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RECOMMENDED PRACTICE FOR PLATING ON ALUMINIUM AND ITS ALLOYS

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Indian Standard

RECOMMENDED PRACTICE FOR PLATING ON ALUMINIUM AND ITS ALLOYS

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Indian Standard

RECOMMENDED PRACTICE FOR PLATING ON ALUMINIUM AND ITS ALLOYS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 9 August 1963, after the draft finalized by the Metallic Finishes Sectional Committee had been approved by the Structural and Metals Division Council.

0.2 Aluminium and its alloys are electroplated with various metals to give them a decorative finish or a finish which is more wear-resistant or to impart some specific properties. Chromium, nickel, copper, brass, tin, zinc, silver and gold may be electroplated on aluminium and its alloys. The uses for plated aluminium may be summarized as follows:

a) Chromium nickel coating provides decorative and increased resistance to corrosion and wear.
b) Copper plating on aluminium confers electrical and thermal conductivity and is also done to provide a surface which can be easily soldered.
c) Brass coating helps bonding with rubber.
d) Tin or chromium plating reduces friction.
e) Zinc plating prevents seizing of the threaded parts.
f) Silver or gold coatings impart decoration and give a surface of high electrical conductivity and radiation resistance.

0.3 The purpose of this standard is to serve as a guide for plating of aluminium and its alloys. These alloys do not generally respond to many of the usual procedures for plating. Hence, different procedures are required to obtain a satisfactory basis for plating. A number of methods are generally used for this purpose, but the zincate dip process which is widely used has been recommended in this standard. Mention may only be made here of other processes, which are also used. These are as follows:

a) Phosphoric acid anodizing,
b) Ferric chloride treatment, and
c) Modified anodizing treatment.

NOTE — A comprehensive bibliography on standards and publications of different countries on various subjects concerning electroplating, as well as references to literature on the above methods, is available with the Indian Standards Institution and can be obtained for reference purposes.

0.4 This standard is one of a series of Indian Standards on electroplating. Other standards published so far in the series cover commercial silver plating; copper, nickel and chromium electroplated coatings; hard chromium plating on steel; electro-tin plating; oxidized copper finishes; cadmium plating; zinc plating; industrial silver plating; copper plating; brass plating; nickel anodes for electroplating; silver anodes for electroplating; tin anodes for electroplating; code of practice for pretreatment of steel, copper and copper base alloys, zinc and zinc base alloys for electroplating; and code of practice for hard chromium plating on steel.

0.5 Metric system has been adopted in India and all quantities and dimensions in this standard have been given in this system.

0.6 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS:2-1960 Rules for Rounding Off Numerical Values (*Revised*). The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

0.7 This standard is intended chiefly to cover the technical provisions relating to plating on aluminium and its alloys, and it does not include all the necessary provisions of a contract.

1. SCOPE

1.1 This standard recommends methods for surface preparation and special pretreatment for aluminium and aluminium alloys required to be electroplated with nickel, chromium, tin, etc.

1.2 This standard is mainly intended for plating aluminium and its alloys both in the wrought and cast forms normally used in the industry.

NOTE — Cast alloys may require a modified pretreatment. The alloy composition shall be furnished to the plater.

2. PRETREATMENT PRIOR TO ZINCATE DIP

2.1 The surface of the article shall be degreased by vapour degreasing or by cleaning with a liquid solvent, such as trichloroethylene or any other suitable substitute. When a liquid solvent is used, it shall, as far as possible, be free from dirt or oil.

2.2 Solvent cleaning shall be followed by treatment with a mild alkaline degreaser having the following composition:

Sodium Phosphate, Tribasic (Na_3PO_4, $12H_2O$)	23 g/l
Sodium Metasilicate ($Na_2Si_2O_5$)	23 g/l

2.2.1 The treatment shall be carried out at a temperature of 60° to 90°C for one-half minute to three minutes depending upon the material and the conditions of the surface.

2.3 Soap base compounds may be removed by treatment in a solution containing sodium carbonate (2 percent) and sodium bicarbonate (4 percent) at a temperature of 35 to 45°C.

2.4 After proper degreasing and rinsing of the metal surface, the work is subjected to an acid etch to remove the oxide film and also the microconstituents present, that may interfere with the formation of a uniform layer of zinc over the surface. If found necessary, a chromic-sulphuric acid etch may as well be used prior to dilute nitric acid immersion. The composition of the bath is as follows:

Chromic Acid (H_2CrO_4)	30 g/l
Concentrated Sulphuric Acid (H_2SO_4)	150 g/l

Operated at a temperature up to 65·5°C up to one minute.

In case of high silicon content, pickling in the following solution done under hood for 2 to 5 minutes at room temperature is considered necessary:

Nitric Acid (sp gr 1·42) (HNO_3)	75 percent (*v/v*)
Hydrofluoric Acid (HF) (48 percent)	25 percent (*v/v*)

The acid dip may be carried out in a polythene lined tank and shall normally be followed by immersion for 30 seconds in dilute nitric acid (1:1).

3. ZINCATE DIP TREATMENT

3.1 The zincate immersion process may be carried out in solutions of different compositions. The generally used one is made up from:

Sodium Hydroxide (N_aOH)	525 g/l
Zinc Oxide (Z_nO)	100 g/l

Operated at a temperature up to 50°C up to three minutes.

The metal surface is gently stirred during the treatment. For treatment of alloys containing copper, the strength of the solution should be reduced by 25 percent.

3.2 The following dilute solution for zincate treatment may also be used:

Sodium Hydroxide ($NaOH$)	80 to 170 g/l
Sodium Cyanide ($NaCN$)	Up to 10 g/l
Zinc Oxide (ZnO)	10 to 30 g/l

NOTE — Dilute solutions are gaining in popularity.

3.3 For wrought alloys with higher magnesium contents and for cast alloys, a modified composition of the zincate immersion process may be adopted to provide more uniform coverage than the conventional bath referred to in **3.1**. The composition of the modified solution is as follows:

Sodium Hydroxide ($NaOH$)	525 g/l
Zinc Oxide (ZnO)	100 g/l
Rochelle Salt [$NaK(C_4H_4O_6), 6H_2O$]	10 g/l
Ferric Chloride ($FeCl_3, 12H_2O$)	1 g/l

3.3.1 The operating conditions, however, remain unaltered. For high silicon content cast alloys, the treatment time shall be reduced to 5 to 10 seconds only.

3.4 A double immersion treatment using separate bath should be generally preferred. The following sequence of treatments should be followed:

a) Zincate treatment,
b) Water rinse,
c) Dilute nitric acid (1 : 1) (*v/v*),
d) Water rinse,
e) Zincate treatment, and
f) Double rinse treatment (running water).

NOTE — The specific gravity of the zincate solution should be checked regularly and any loss of the viscous liquid due to drag out may be replenished by fresh solution of the specified composition.

3.5 General plating procedures for wrought and cast alloys are as follows:

For Wrought Alloys	*For Cast Alloys*
a) Preliminary cleaning	a) Preliminary cleaning
b) Chromic-sulphuric acid pickle	b) Nitric acid dip
c) Dip in nitric acid	c) 5 percent caustic soda dip
d) Zinc immersion treatment	d) Nitric-hydrofluoric acid dip
e) Electroplating	e) Nitric acid dip
	f) Zinc immersion treatment
	g) Electroplating

NOTE — In the above treatments, control of time and temperature, wherever specified, should be strictly adhered to.

4. RINSING

4.1 Thorough and effective rinse treatments in clean running water are essential requirements after every step in cleaning, conditioning and plating operations. In the case of zinc immersion treatments, two successive rinses will be necessary to remove the last traces of viscous zincate solution. In such double rinse treatments, a dip in running water followed by a spray is more effective. Rinse water should be reasonably clean and should be discarded when it gets more contaminated.

5. RACKING

5.1 In the plating of aluminium, racks should be made from commercial purity aluminium or from the alloy similar to that being plated. The contact should be strong and sound and as such only spring contacts are satisfactory; because of the specific gravity of aluminium being low, gravity contacts are not considered adequate for such purposes. Even though appropriate alloys may be used for the gripping parts, pure aluminium is preferred for components carrying the main current in the racks or jigs designed for such uses. Titanium may also be used if available.

6. PLATING AFTER ZINCATE TREATMENT

6.1 Plating solutions should be such as to have minimum chemical action on the aluminium surface and electrical contacts should invariably be established before putting the work in the electrolytes, so that immersion deposits formed by substitution process may not affect the adhesion of the subsequent electro-deposits.

6.2 Copper Strike — If copper strike is found necessary, the following composition is recommended for this purpose:

Cuprous Cyanide ($CuCN$)	22·5 g/l
Sodium Cyanide ($NaCN$)	29·9 g/l
Sodium Carbonate ($Na_2CO_3H_2O$)	15·0 g/l
Rochelle Salt [$NaK\ (C_4H_4O_6)\ 6H_2O$]	59·9 g/l
Free Sodium Cyanide Content	0·3 to 0·5 percent
*p*H	10·2 to 10·5
Temperature	Up to 60°C
Current Density	1 to 1·6 A/dm^2

6.2.1 A copper pyrophosphate bath may also be employed for obtaining the primary electro-deposited coating on to zinc deposits. The bath should be worked at a *p*H of 7·0 to 7·5 and a temperature of 43 to 60°C with a current density of about 0·2 to 0·4 A/dm^2. The coating produced is bright and is suitable for subsequent bright nickel deposits.

6.3 Brass Strike — When brass is deposited on zincate coating, the following composition of the solution is recommended:

Cuprous Cyanide (CuCN)	32·4 g/l
Zinc Cyanide (ZnCN)	9·4 g/l
Sodium Cyanide (NaCN)	56·1 g/l
Sodium Carbonate (Na_2CO_3)	29·9 g/l
Ammonium Hydroxide (NH_4OH) (20 percent)	2 ml/l
Free Sodium Cyanide Content:	18·7 g/l
Temperature	27 to 35°C
Current Density	0·3 to 0·5 A/dm^2

7. NICKEL PLATING

7.1 Nickel plating shall be done by any of the recommended methods for bright and matt finish. Direct plating of nickel on aluminium after zincate treatment is also gaining in popularity.

7.1.1 As deposited, the nickel is grey and has a glossy appearance. The deposit may be polished to a white lustrous finish.

8. CHROMIUM PLATING

8.1 Chromium is usually deposited on a nickel undercoating but may also be plated direct over the zinc deposit. In such cases, a preliminary flash coating is given at 20°C and is followed by heavier deposits at higher temperatures from the usual chrome plating solutions.

9. TIN PLATING

9.1 For tin plating on the zinc immersion coating, the metal may be deposited from a sulphate or stannate bath.

10. ZINC PLATING

10.1 Zinc plating from a cyanide solution usually blisters and deposits from a pyrophosphate bath are, therefore, preferred.

11. CADMIUM PLATING

11.1 Cadmium may be plated direct after a preliminary strike for one minute has been given in a solution containing 1·25 percent of cadmium and 5 percent of total cyanide. Alternatively, an initial flash coating of copper or brass prior to cadmium plating from the usual bath solutions will also be suitable.

12. SILVER PLATING

12.1 Silver is plated in the usual manner after giving a silver strike in a solution containing:

Silver Cyanide (AgCN)	1·86 g/l
Potassium Cyanide (KCN)	74·4 g/l

For plating, a temperature of 21 to 27°C and a current density of 0·1 to 0·4 A/dm^2 should be used. Mercury solutions should not be used to increase the adhesion of the silver.

INTERNATIONAL SYSTEM OF UNITS (SI UNITS)

Base Units

Quantity	*Unit*	*Symbol*
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Luminous intensity	candela	cd
Amount of substance	mole	mol

Supplementary Units

Quantity	*Unit*	*Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

Derived Units

Quantity	*Unit*	*Symbol*	*Definition*
Force	newton	N	1 N = 1 $kg.m/s^2$
Energy	joule	J	1 J = 1 N m
Power	watt	W	1 W = 1 J/s
Flux	weber	Wb	1 Wb = 1 V.s
Flux density	tesla	T	1 T = 1 Wb/m^2
Frequency	hertz	Hz	1 Hz = 1 c/s (s^{-1})
Electric conductance	siemens	S	1 S = 1 A/V
Electromotive force	volt	V	1 V = 1 W/A
Pressure, stress	pascal	Pa	1 Pa = 1 N/m^2

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